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(71) Applicant: ERICSSON INC. [US/US]; 7001 Development Drive, P.O. Box 13969, Research Triangle Park, NC 27709 (US).

(72) Inventors: WYNN, Stephen, R.; 507 Oak Trail, Lynchburg, VA 24502 (US). MACK, Andrew, S.; 1103 Shadow Peak Road, Forest, VA 24551 (US).

(74) Agent: FARIS, Robert, W.; Nixon & Vanderhye P.C., 8th floor, 1100 North Glebe Road, Arlington, VA 22201-4714 (US).

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(54) Title: TRUNKED RADIO SYSTEM USING DUAL RECEIVER ARCHITECTURE TO IMPROVE EFFICIENCYY, PERFORMANCE AND ACCESS TIMES

(57) Abstract

A portable or mobile radio terminal simultaneously monitors an active temporarily assigned working channel annd the system control channel of a trunked radio communications system. This arrangement provides many advantages including, for exaample, better system efficiency, better performance and faster access times. In one example arrangement, the portable or mobile radio includdes a digital receiver that down converts the entire system band and uses advanced digital techniques to select the control channel and actiive working channel frequencies. The basic concept of rethinking the radio architecture has the potential of removing significant constraaints on the overall trunked system design – and therefore transforming forever the way future trunked radio systems of any kind are desiggned.

TRUNKED RADIO SYSTEM USING DUAL RECEIVER ARCHITECTURE TO IMPROVE EFFICIENCY, PERFORMANCE AND ACCESS TIMES

Field Of The Invention

This invention relates to radio communications, and more specifically, to techniques for improving efficiency, performance and access times of trunked radio communications systems. In still more detail, the present invention relates to trunked radio system improvements that can be realized by providing radio terminals with simultaneous dual channel receive capability.

Background Of The Invention

State of the art trunked radio communications systems typically include at least one RF control channel and one or more RF working channels. Radio terminals have in the past been treated as a single channel receiver that is switched between the control channel and a working channel as needed.

In general, the control channel is the source of all system information to terminals in the idle state. When a terminal is not actively engaged in communications, it monitors the control signaling the trunked radio system transmits over the control channel.

The terminals use the control channel for information needed to set up a connection on a separate channel defined as a working channel.

For example, when one or more terminals are to participate in a call, the system temporarily assigns a free RF working channel for their use, and sends the terminals a corresponding channel assignment command over the system control channel. Upon receiving the channel assignment command, the terminal(s) switch to the assigned working channel, and use the working channel for a single or multiple transmission communication. Upon completing the call on the working channel, the terminal(s) return to monitoring the control channel signaling on the control channel.

In such prior art trunked systems, terminals are unable to receive control channel signaling while operating on the working channel. Despite this limitation, there is a need to communicate control signaling to terminals while they are actively engaged in working channel communications. For example, a "priority scan" feature may require a terminal to rapidly switch from one working channel to another in order to participate in higher priority communications. See, for example, commonly assigned U.S. Patent No. 4,939,746 to Childress et al.

To solve this problem, it is known to provide sub-channel signaling on the working channel. Such sub-channel signaling is used to send trunked system control information to terminals while they are receiving working channel signaling. The above-referenced

Childress et al. patent describes a technique in which the working channel may be provided with a form of (typically) slower rate "sub-audible" control signaling capability to allow the system to communicate control information to terminals while they are actively engaged in receiving voice or data on a working channel. The sub-channel signaling may, for example, comprise sub-audible signaling, embedded digital signaling such as SAACH/FAACH, etc.

At least in dispatch-based trunked land mobile radio systems, the working channel sub-channel signaling may be a replication of a subset of the information already available on the control channel. For example, working channel sub-channel signaling intended to enable "priority scan" may duplicate control channel signaling allowing for late entering terminals. The system working channel transmitting equipment has a means to insert this control information on to a working channel carrying desired working channel voice or data information – and terminals are provided with means to extract the control information from the received working channel signaling. The net effect of this existing approach is to distribute the control task across all channels.

While trunked radio systems using working channel sub-channel signaling have been highly successful, this technique has certain drawbacks. For example:

- Sub-audible signaling on the working channel reduces analog signal deviation (and/or signal-to-noise ratio) of the

analog signal -- or effective working channel bit or framee rate in a digital system.

- Because the sub-channel signaling must share the workimg channel bandwidth with voice or data, the sub-channel signaling is typically transmitted at a relatively slow rate: -- creating timeliness problems.

- When it is necessary to transmit higher speed control signaling over an assigned working channel (e.g., to accomplish timely handoffs), the control signaling can bee "bursted" at a higher rate (see Childress et al patent) -- buut such "bursting" interrupts the normal working channel voice or data signaling to cause an undesirable phenomemon sometimes referred to as "audio punch through."

- It takes time for a terminal to resynchronize upon switchiing between the control channel and a working channel; techniques such as "loose synchronization" between conttrol and working channels (see Childress et al patent) can minimize resynchronization time at the cost of some additional system complexity.

- System protocols and associated complexity must accommodate redundant control signaling on control and working channels.

- System control and working channel base station equipment must be coordinated in complex ways to distribute the control task across all channels.

- System functional blocks must perform mixed functions (e.g., some control functions and some voice/data communications functions) – further complicating system design.

It has long been known to provide dual channel receive capabilities in non-trunked radio contexts. For example, some prior art military tunable receiving units included an auxiliary, fixed channel (e.g., crystal controlled) "guard channel" receiver that constantly monitored a certain fixed frequency for emergency or other high priority calls. See also U.S. Patent No. 4,287,599 to Goncharoff et al, which discloses a single radio unit including simultaneously active Citizen's Band and AM broadcast band receivers (the user can listen to AM radio knowing that his radio will route the CB receiver output to the speaker instead of the AM broadcast receiver output whenever there is an incoming CB signal).

Summary of the Invention

In contrast to prior trunked radio systems, the present invention provides terminal dual channel receive capability to simplify trunked system architecture and improve trunked system efficiency, performance and access times.

In accordance with one aspect provided by this invention, a trunked radio communications system includes at least one mobile or portable radio that receives control signaling over at least one RF control channel and simultaneously receives voice and/or data over at least one temporarily assigned working channel. The radio unit can thus substantially simultaneously receive control signaling over the RF control channel, and voice and/or data over the RF working channel.

In accordance with another aspect provided by this invention, system control channel base station equipment transmits at least some control signaling to a radio over the RF control channel at the same time that system working channel radio equipment transmits information signals to the same radio over the temporarily assigned RF working channel.

The present invention provides the following advantageous features and advantages:

- The overall trunked radio system is streamlined and simplified by using the advantages of state-of-the-art digital receiver design.
- Radios have multiple information sources each contributing to overall performance in real time.
- The working channel is simpler and better utilizes its spectrum, while the control channel provides data speed control so as to quickly and transparently modify radio activity without added control burden on the working channel.
- No longer necessary working channel sub-channel (e.g., sub-audible) signaling can be removed, increasing analog deviation to give better system signal-to-noise ratio (or an additional effective bit rate in a digital system since bits are recovered for use by the working channel data stream).
- Assignment speed for switching to the working channel can be virtually zero.
- The effects of synthesizer switching kick can be reduced.
- System hand-offs can be virtually transparent.
- Overall system protocols and complexity can be simplified.
- No longer necessary to "punch holes" in audio data streams for messaging.
- Real time frequency lock on the control channel can continue past channel assignment – and improving working channel

synchronization making it unnecessary for the working channel to perform control channel synchronization functions.

- The control channel truly becomes the ultimate system control – not just the temporary messenger.
- System messaging traffic between control channel equipment and working channel equipment (e.g., via a backup serrial link) is simplified.
- Response time for many system features (e.g., system all-calls) can be improved.
- New features (e.g., simultaneous voice and data and/or extended data rate) may be feasible even on old analog systems by enabling radio units to receive two working channels simultaneously.
- Allows a more modular, cost-effective system approach whereby functional blocks are more generic and therefore more easily reconfigured and duplicated (e.g., to provide built-in redundancy).

Various techniques can be used to provide radio dual channel simultaneous receive capabilities. For example, the radio can use a digital receiver to simultaneously monitor both the active working channel and the system control channel. In another example, the entire receiver structure can be duplicated to provide separate, independent control channel and working channel receivers. In still another example, a digital receiver of the type described in co-pending, commonly-assigned U.S. Patent application serial No.

______ of Wynn et al. Filed May 8, 1997 entitled "Multi-Channell Base Station/Terminal Design Covering Complete System Frequency Range" (attorney ref. 46-924) (incorporated by reference herein) is used to provide simultaneously control channel and working channel receive capability. Using such a full band demodulation technique in which two channels are ultimately received provides an added benefit of virtually zero synthesizer switching speed when switching between the control channel and an assigned working channel.

The basic concept provided by this invention of re-thinking the terminal architecture has the potential of transforming forever the way future trunked radio systems of any kind are designed.

Brief Description Of The Drawings

These and other features and advantages provided in accordance with the present invention may be better and more completely understood by referring to the following detailed description of presently preferred example embodiments in conjunction with the drawings, of which:

Figures 1A-1C show a simplified prior art trunked radio communications system;

Figure 2 shows a simplified example trunked radio communications system provided in accordance with a presently preferred example embodiment of this invention;

Figure 3 shows a more detailed simultaneous control channel and working channel receive capability example provided by this invention; and

Figure 4 shows an example dual conversion super-heterodyne multiple channel receiver provided by a preferred embodiment of this invention.

Detailed Description Of Presently Preferred Example Embodiments

Figures 1A-1C show an example simplified prior art trunked radio communications system including base station equipment 10 and terminal equipment 12. Base station equipment 10 may comprise, for example, a conventional stationary base station including plural repeaters 14. Terminal equipment 12 may comprise, for example, a radio transceiver that communicates wirelessly with other terminal equipment and/or land-based services (e.g., telephone interconnects) via base station equipment 10. Examples of terminals 12 include a handheld miniature “handie talkie”; a vehicle-mounted mobile radio transceiver; a cellular phone type radio transceiver; a stationary wireless dispatch transceiver; and a mobile or stationary wireless data terminal.

In general, base station equipment 10 wirelessly exchanges digital control information with terminal 10, and temporarily assigns a working channel for use by the terminal to wirelessly transmit or

receive information such as voice or data. Base station equipmentt 10 in this example includes at least one repeater 14(1) for transceiving working channel information, and at least one repeater 14(N) for transceiving control channel information.

Control channel repeater 14(N) transmits and receives contrrol channel information over a dedicated RF control channel. Workimg channel equipment 14(1) transmits and receives working channel information over a temporarily assigned RF working channel. In tthis example, control channel repeater 14(N) and working channel repeater 14(1) are capable of transmitting their respective signaling simultaneously, but terminal 12 is unable to simultaneously receiwe the control and working channel information because they are transmitted over two different radio frequencies.

In this example, terminal 12 monitors the control channel signaling transmitted by control channel repeater 14(N) when it is idle and is not actively engaged in communications. Upon receiviing a channel assignment message transmitted over the RF control channel (e.g., in response to a request the terminal transmitted over the control channel or in response to some other system event), terminal 12 changes its receiver operating frequency to the assigneed working channel and begins receiving working channel signaling ((see Figure 1B) transmitted by working channel repeater 14(1). In thiss state in which the terminal 12 is operating on the assigned workingg channel, the only way base station equipment 10 can transmit conttrol

information to the terminal is to provide it over sub-channel signalling on the assigned working channel. Because the working channel is simultaneously carrying working channel signaling (e.g., data or voice), the working channel repeater equipment 16 generally must transmit such information at a reduced rate (and/or only momentarily) to avoid disrupting the working channel voice and/or data signaling.

Figure 1C shows that terminal 12 has a single receiver 13 used to receive both control and working channel signaling. During operation on a working channel, base station equipment control channel repeater 14(N) continually transmits control channel signaling over the system control channel frequency, and also provides control channel signaling to each of working channel repeaters 14(1), ..., 14(k) via a connection such as a backup serial link 15 (see commonly-assigned U.S. Patent No. 5,274,838 to Childress et al). Active working channel repeaters 14(1) ... 14(k) transmit some or all of the control channel signaling (typically at reduced data rates) over the working channels to terminals 12 engaged in working channel communications.

Figure 2 shows a simplified preferred embodiment example in accordance with this invention. In this example, terminal 22 has two receivers 30, 32. Using these two receivers 30, 32, terminal 22 can simultaneously receive:

- control channel signaling transmitted by control channel repeater 24 over an RF control channel, and
- working channel signaling transmitted by working channel repeater 26 over an assigned working channel.

As discussed above, this arrangement provides a number of advantages including, for example, more timely receipt of control information during active working channel communications and simplified overall base station equipment 10 architecture. For example, as shown in Figure 2, it is no longer necessary for control channel repeater 14(N) to continually provide control channel signaling to working channel repeaters 14(1) ... 14(k) for transmission over the active working channels – since terminal 12 can receive control channel signaling and working channel signaling simultaneously. Thus, although the basic channel control and site interface for backup and redundancy as described in U.S. Patent No. 5,274,838 can continue to be used to provide "fail safe" operation in the event control channel repeater 14(N) (or other base station equipment 10 component) fails, it is no longer necessary for each of working channel repeaters 14(1) ... 14(k) to continually transmit control channel signaling over active working channels.

The basic novel architectural structure of a trunked radio system shown in Figure 2 is applicable to all future designs of trunked systems that use multiple channels of which one or more channel is a user or working channel and at least one other channel is

used as a control channel. This applies to virtually all wireless telephone systems from cellular to land mobile radio to PCS.

Figure 3 shows an example simplified dual receiver terminal 22 architecture. In the Figure 3 example, terminal 22 includes a control channel receiver 30 and a working channel receiver 32. Control channel receiver 30 and working channel receiver 32 operate simultaneously on different (e.g., programmable) radio channels. In this example, control channel receiver 30 receives channel assignment, status and other control signals that base station control channel repeater 24 transmits over an RF control channel; and working channel receiver 32 receives voice or data that base station working channel repeater 26 transmits over an assigned RF working channel. Control channel receiver 30 and working channel receiver 32 operate simultaneously and independently in this example. Thus, terminal 22 can receive the control channel status and other signaling at the same that working channel receiver 32 receives voice or data on a temporarily assigned working channel.

In this example, terminal 22 includes a main controller 34 responsive to control channel signaling received by control channel receiver 30. Main controller 34 may, for example, program working channel receiver 32 to operate on a particular working channel. Main controller 34 may also program a transmitter 36 to operate on one or more assigned RF channels (e.g., to transmit control information to base station control channel repeater 24 over the control channel

and/or to transmit working channel voice or data information to base station working channel repeater 26 over a temporarily assigned working channel).

The radio communications system shown in Figures 2 and 3 operates more efficiently, has higher performance and faster access times than prior techniques. For example, since terminal 22 is able to continuously monitor the system control channel even while it is engaged in a working channel communiqué, there is no need to transmit control information over the assigned working channel. This allows working channel performance to be increased. For example, the working channel analog deviation for analog signaling (or bit rate for digital signaling) is effectively increased – providing better system signal-to-noise ratio and information throughput. Additionally, the control channel signaling that terminal 22 has continuous access to is transmitted at high speed (e.g., 9600 bps) — providing more timely control channel signaling than can be provided using slower rate working channel sub-channel techniques such as sub-audible signaling. Terminal 22's continuous access to high-speed control channel signaling eliminates the requirement for interrupting the working channel with high speed control signaling data bursts – so that "punching holes" in audio data streams for messaging is not required. System hand-offs can thus be virtually transparent. Response times for many system features (e.g., system all-calls) can be improved.

Other advantages are provided by the architecture shown in Figure 3. For example, the control channel truly becomes the ultimate system control – not just the temporary messenger. Because it is no longer necessary to closely coordinate certain signaling protocols transmitted on the control and working channel, overall system protocol and complexity can be simplified. Additionally, the synchronization of receivers 30, 32 with control and working channel signaling becomes simplified. For example, real time frequency lock on the control channel can continue past channel assignment – making it unnecessary for the working channel signaling to be synchronized with control channel signaling. This may improve synchronization on the working channel, and eliminates time delays in terminal 22 acquiring the control channel after a working channel communication. Additionally, the architecture shown in Figure 3 allows a more modular, cost-effective system approach whereby functional blocks are more generic and therefore more easily reconfigured and duplicated (e.g., for built-in redundancy). Further, system messaging traffic (e.g., over a "back up" serial link – BSL) connecting control channel repeater 24 with working channel repeater 26 is simplified considerably.

Figure 4 shows, in block diagram form, an example receiver structure that can be implemented in terminal 20 to simultaneously receive working channel and control channel signaling. Many receiver structures may be utilized – this represents only one such

method. The proposed receiver structure shown in Figure 4 duplicates the standard prior art dual conversion super heterodyne receiver to provide two identical, independently operable receivers 30, 32 – one for the working channel and one for the control channel. The control channel data is fed to the terminal's main controller or microcomputer 34. The addition of this additional receiver 32 means that the working channel has gotten simpler and better utilizes its spectrum, while the control channel provides high data speed control over terminal 22 needed to quickly and transparently modify the activity of the terminal without the added control burden on the working channel. The basic concept of re-thinking the terminal 22 architecture has a potential of removing significant constraints on trunked radio system design -- transforming forever the way future trunked radio systems of any kind are designed – obviously for the better.

In the Figure 4 example arrangement, an antenna 100 is connected to the input of receiver 32, and also to the input of receiver 30. Receivers 30, 32 each comprise a conventional superheterodyne receiver (e.g., of the type that may be implemented in whole or in part on more or more integrated circuits). Receivers 30, 32 may thus comprise a first mixer 102 (102') supplied with a first local oscillator frequency by a first local oscillator 104 (104'); a first intermediate frequency filter 106 (106'); a second mixer 108 (108') supplied with a second local oscillator frequency by a second local oscillator 110

(110'); a second intermediate frequency filter 112 (112'); and a frequency or phase discriminator 114 (114'). The output of receiwer 32 discriminator 114 provides working channel information. Simultaneously, receiver 30 discriminator 114' supplies control channel information that is detected by a control detector 116 and supplied to a main controller 34.

In another example, advanced digital receiver techniques off the type described in the above-referenced co-pending Wynn et al. pattent application may be used to provide dual channel receive capabilityy. The advantage of this approach is to reduce to virtually zero, the assignment speed for switching to the working channel, and reducting the effects of synthesizer switching "kick."

In another variation on the above-described arrangement, thte control channel receiver 30 and working channel receiver 32 of terminal 22 may be used to simultaneously receive two (or more) working channels. This mode – which can be activated when neecded or desired – can be used to provide simultaneous voice and data working channel communications, or extended data rates for example. In one specific embodiment, two working channels can each carry half the information to provide twice the transmission rrate of a single working channel.

While the invention has been described in connection with what is presently considered to be the most practical and preferredl embodiment, it is to be understood that the invention is not to be

limited to the disclosed embodiment, but on the contrary, is intendded to cover various modifications and equivalent arrangements includded within the spirit and scope of the appended claims.

WE CLAIM:

1. In a trunked radio communications system of the type including at least one movable radio that receives control signaling over at least one RF control channel and receives voice and/or data over at least one temporarily assigned RF working channel, an improved method including the step of substantially simultaneously receiving, with the movable radio, the control signaling over the RF control channel and the voice and/or data over the RF working channel.

2. A method as in claim 1 wherein the simultaneously receiving step includes the step of receiving the RF control channel signaling and the RF working channel signaling using two independent radio receivers.

3. A method as in claim 1 wherein the simultaneously receiving step includes the step of downconverting a band of signals and selecting the RF control channel and RF working channel from the downconverted signal band.

4. A method as in claim 1 wherein the simultaneously receiving step includes maintaining synchronization with the control

channel while at the same time receiving signaling on the working channel.

5. A method as in claim 1 wherein the simultaneously receiving step comprises simultaneously receiving signaling from multiple information sources, and using the signaling from the multiple information sources to contribute to the performance of the radio in real time.

6. A method as in claim 1 wherein the receiving step includes the steps of:

(a) receiving a channel assignment message over the control channel; and

(b) beginning to receive signaling on the working channel in response to receipt of the channel assignment message.

7. A method as in claim 6 wherein step (b) is performed virtually instantaneously with zero switching time upon receipt of the channel assignment message by step (a).

8. A method as in claim 6 further including the step of maintaining real time frequency lock on the control channel after sstep (b).

9. A method as in claim 1 further including the step of operating the radio in a mode wherein it simultaneously receives signaling on two different temporarily assigned working channels..

10. In a trunked radio communications system of the type including at least one control channel base station and at least one working channel base station, the control channel base station transmitting channel assignment signaling over at least one RF control channel to at least one radio terminal, the radio terminal operating on at least one temporarily assigned RF working channell in response to the channel assignment signaling transmitted over the IRF control channel, an improved communication method comprising:
(a) transmitting information signals to the radio terminal over the temporarily assigned RF working channel; and
(b) substantially simultaneously with step (a), transmitting at least some control signals to the same radio terminal over the RF controbl channel.

11. A method as in claim 10 wherein step (b) comprises providing high speed data to quickly and transparently modify radiio

terminal activity without adding control signaling burdens on the working channel.

12. A method as in claim 10 wherein step (a) includes the sstep of avoiding the transmission of a control signaling sub-channel om the working channel.

13. A method as in claim 10 wherein step (a) includes the sstep of using substantially all of the working channel bandwidth for signaling supporting voice communications.

14. A method as in claim 10 further including the step of defining the control channel as the ultimate system control.

15. A trunked radio communications system of the type thaat supports at least one radio terminal, the system comprising:

at least one control channel base station that transmits chanmel assignment and other control signaling to the radio terminal over aat least one RF control channel; and

at least one temporarily assigned working channel base statiion that transmits information signaling to the radio terminal over at leeast one working channel, the radio terminal operating on the RF workcing

channel for the duration of a call in response to the channel assignment signaling transmitted over the RF control channel,

wherein the working channel base station and the control channel base station simultaneously transmit signaling to the radio terminal for the duration of the call.

16. A method as in claim 15 wherein the radio terminal simultaneously receives working channel signaling and control channel signaling for the duration of the call.

17. In a trunked radio communications system architecture including at least one control channel transmitter that transmits control channel signaling over an RF control channel and at least one working channel transmitter that transmits working channel signaling over an RF working channel, an improvement comprising allowing at least one mobile or portable radio unit to simultaneously receive the control channel signaling and the working channel signaling.

18. A trunked radio terminal comprising:

a first receiving arrangement that receives control signaling over at least one RF control channel, and

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q7/28 H04Q7/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 625 874 A (UCHIDA WATARU ET AL) 29 April 1997 see the whole document ---	1,100,15, 17,118
A	EP 0 725 551 A (NEDERLAND PTT) 7 August 1996 see column 10, line 36 - column 12, line 18 ---	1,100,15, 17,118
A	EP 0 780 993 A (LUCENT TECHNOLOGIES INC) 25 June 1997 see the whole document -----	1,100,15, 17,118

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Kelperis, K

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Information on patent family members

national Application No
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5625874 A	29-04-1997	JP 2616417 B	04-06--1997
		JP 7184251 A	21-07--1995
		SE 9404476 A	25-06--1995
		US 5678183 A	14-10--1997
EP 0725551 A	07-08-1996	NL 9500192 A	02-09--1996
EP 0780993 A	25-06-1997	JP 9186620 A	15-07--1997